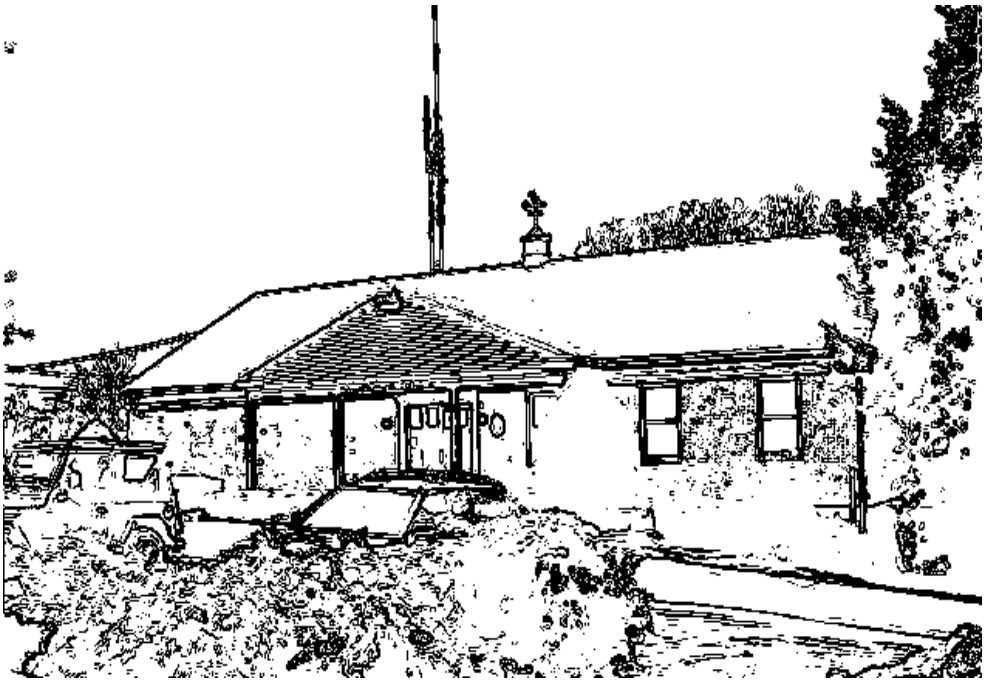
INDOOR AIR QUALITY ASSESSMENT

North Andover Police Department
566 Main Street
North Andover, Massachusetts



Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
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Background/Introduction

In response to a request from the North Andover Health Department and Chief Richard Stanley of the North Andover Police Department (NAPD), an indoor air quality assessment was done at the North Andover Police Station (police station) at 566 Main Street, North Andover, Massachusetts. This assessment was conducted by the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA). On March 21, 2001 a visit was made to this building by Cory Holmes, Environmental Analyst of the Emergency Response/Indoor Air Quality (ER/IAQ) Program. Richard Boettcher, NAPD Communications Officer, accompanied Mr. Holmes during the assessment. BEHA staff received complaints of eye and throat irritations as well exacerbation of allergies that building occupants believed to be attributed to the building.

The NAPD is a one-story red brick building constructed in 1967. The building was renovated in the early 1990's during which a portable structure that houses the detective unit was attached to the rear of the building (see Picture 1). The ground floor of the NAPD consists of the dispatch area, prisoner-processing area, holding cells and office space for senior law enforcement officers and support personnel. Located in the basement are the police chief and secretary's offices, roll call room, locker room, restrooms, evidence room and the armory.

System Builders Inc. (SBI), a heating, ventilation and air conditioning (HVAC) consultant assessed the condition/replacement of the existing HVAC system. The SBI report made four recommendations for the basement: (1) replacement of the duct system and air handling unit (AHU); (2) installation of a modulating outside fresh air damper; (3) the installation of a new HVAC control system; and (4) the installation of a new exhaust ventilation

system for the chief's office, secretary's area, locker room and briefing room. The SBI report also contained four recommendations for the first floor: (1) replace the four-ton HVAC unit and existing ductwork with a five-ton unit to provide additional cooling for the booking/cell areas, (2) install a modulating outside air damper, (3) install a new HVAC control system, and (4) install a new exhaust system and ductwork (SBI, 2000).

Methods

Air tests for carbon dioxide, carbon monoxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor.

Results

The NAPD operates 24 hours a day, has a staff of 10-12 and is visited by approximately 20-30 members of the public daily. The tests were taken under normal operating conditions. Test results appear in Tables 1-4. Air samples are listed in the tables by location that the air sample was taken.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were above 800 parts per million parts of air [ppm] in nineteen of twenty-three areas sampled throughout the building, indicating inadequate air exchange in most of the areas surveyed. An HVAC system located in the attic

provides ventilation for the ground floor (see Picture 2) through ducted, ceiling vents (see Picture 3). Exhaust ventilation is provided by ceiling-mounted exhaust grilles, which return air to the AHU via ductwork (see Picture 4). The AHU has no means to introduce fresh air. In this configuration, the AHU only tempers and recirculates air within the police station. It appears that the building was originally designed to provide fresh air to interior spaces solely through openable windows.

Exhaust ventilation is provided to the booking and prisoner cellblock areas by a mechanical system connected to an attic exhaust motor via ductwork (see Picture 5). This system was not in operation during the BEHA assessment. With the lack of fresh air supply and exhaust ventilation, pollutants that exist in the interior space cannot be diluted and will build up and remain in the indoor environment.

Ventilation for the basement storage areas and offices is provided by an AHU, which also had no provision for the introduction of fresh air. Exhaust ventilation for these areas is provided by a single wall-mounted return vent in the secretary's office (see Picture 6). Passive grills are mounted on doors (e.g., Chief's office & briefing room) to draw air into the secretary's office and out of the building through the exhaust vent located in the radio room (see Pictures 7 & 8). Carbon dioxide readings in these areas were slightly above 800 ppm, which as discussed previously can indicate inadequate air circulation. Mechanical exhaust vents in basement restrooms (including the Chief's office) were operating at the time of the assessment; however, each was drawing air very weakly and may not be sufficient to provide proper exhaust. In addition, exhaust ductwork for restroom vents must travel a great distance (across the entire length of the basement) then go through a series of 90^{o} angles before reaching the exhaust

terminus on the exterior wall (see Picture 8). Airflow is decreased roughly in half by every 90^{o} angle that exists in ductwork. BEHA staff observed damaged flexible ductwork above ceiling tiles in the basement restroom (see Picture 9).

Ventilation for the detective unit is provided by a ducted air-handling unit (AHU) located on the exterior wall of the structure (see Picture 10). Fresh air is distributed to work stations via ductwork connected to ceiling-mounted air diffusers. Return vents draw air back to the units through wall or ceiling-mounted grilles (see Picture 11). A thermostat controls the HVAC system. The thermostat has settings of "on" and "automatic". Thermostats were set to the "automatic" setting during the assessment (see Picture 12). The automatic setting on the thermostat activates the HVAC system at a preset temperature. Once the thermostat reaches a preset temperature, the HVAC system is deactivated. Therefore no mechanical ventilation is provided until the thermostat re-activates the system.

To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of occupancy. In order to have proper ventilation with a mechanical ventilation system, the system must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. The date of the last balancing of these systems was not available at the time of the assessment. It is recommended that existing ventilation systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994).

The Massachusetts Building Code requires a minimum ventilation rate of 20 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied.

Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week based on a time weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches.

Temperature measurements ranged from 65^{o} F to 75^{o} F, which were below the BEHA recommended comfort range for some areas. The BEHA recommends that indoor air temperatures be maintained in a range of 70^{o} F to 78^{o} F in order to provide for the comfort of building occupants. A number of complaints of uneven heating and cooling were expressed to BEHA staff, specifically cold temperatures in the cellblock area. As mentioned previously, exhaust ventilation in this area (see Picture 13) was not operating during the BEHA assessment. The assessment occurred on a cold day. Backdrafting air from cellblock area vents was noted,

which can lead to temperature complaints. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity in this building ranged from 25 to 34 percent, which is below the BEHA recommended comfort range. The BEHA recommends a comfort range of 40 to 60 percent for indoor air relative humidity. Relative humidity levels would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

Water stained ceiling tiles were observed in some areas of the police station. Water-damaged ceiling tiles can provide a source of microbial growth and should be replaced after a water leak is discovered. Active leaks were reported in the support services office and in Lt. Carney's/OIC office. The basement storeroom had stained ceiling tiles, one exhibiting possible mold growth (see Picture 14). A vertical rust colored stain was seen on the wall below this area indicating an historical leak. BEHA staff examined the ceiling plenum. No current sources of moisture or active microbial growth were seen. Cardboard boxes were stored on the floor beneath the general area of the water-damaged ceiling tiles. A black substance, which may be mold, was noted on the floor beneath several of these boxes (see Picture 15). Like other porous materials, if colonized with mold they must be discarded.

Active mold growth was noted on the gypsum wallboard of the storeroom in the secretary's area (see Picture 16). Building occupants reported that the area of microbial growth has been cleaned and disinfected repeatedly. No obvious sources of interior moisture problems were noted. BEHA staff observed conditions along the outside perimeter of the building adjacent to this area to identify breaches in the building envelope, which would provide a source of water penetration. The most likely sources were along the exterior wall/tarmac junction and/or a utility hole created in the concrete foundation for electrical wires (see Pictures 17 & 18). The rear of the building is not equipped with a gutter system (see Picture 1) which can allow rainwater to run down the side of the building and pool against the foundation depending on wind and weather conditions. Spaces between the tarmac and exterior walls of the building can bring moisture in and eventually lead to cracks and/or fissures in the foundation below ground level. This can breach the integrity of the building envelope and serve as a source of water penetration and subsequent water damage to building materials (e.g., gypsum wallboard).

Like other porous materials, if gypsum wallboard becomes wet repeatedly it can provide a medium for mold growth. Mold and related particulates can be irritating to sensitive individuals. Water-damaged gypsum wallboard cannot be adequately cleaned to remove mold growth. Once mold has colonized, discarding the material is advised. Removing the water-damaged gypsum wallboard will also give maintenance personnel the opportunity to observe conditions within the wall cavity and to determine characteristic signs of water penetration through breaches of the building envelope.

The exterior door of the detective unit was severely corroded by water damage (see Picture 19). Drafts were noted and light could be seen penetrating through a hole in the door.

Rusted metal chips were also noted in the area (see Picture 20). The floor around this door is carpeted. Depending on wind and weather conditions, rainwater can penetrate through the space and wet carpeting and other porous building materials. The American Conference of Governmental Industrial Hygienists (ACGIH) recommends that carpeting be dried with fans and heating within 24 hours of becoming wet (ACGIH, 1989). If carpets are not dried within this time frame, mold growth may occur. Once mold has colonized porous materials, they are difficult to clean and should be removed.

Other Concerns

Several conditions that can potentially affect indoor air quality were also identified. BEHA staff examined the AHU in the attic and found the filter coated with dirt/dust and accumulated material (see Picture 21). A debris-saturated filter can obstruct airflow and may serve as a reservoir of particulates that can be re-aerosolized and distributed to occupied areas via the ventilation system. In addition, the filter access panel was not re-installed and was located approximately two-feet from the unit on the fiberglass insulation (see Picture 22). If not installed, the lack of the filter access panel will render the AHU casing non-airtight and will draw air from the attic space into the unit. As air bypasses filters, the opportunity exists for airborne dirt, dust and particulates to be distributed to occupied areas via the HVAC system. Aerosolized dust, particulates and fiberglass can provide a source of eye, skin and respiratory irritation to certain individuals. In addition, these materials can accumulate on flat surfaces (e.g., desktops, shelving, and carpets) in occupied areas and subsequently be re-aerosolized causing further irritation.

A portable air conditioning unit is mounted in the wall of the dispatch area. BEHA staff inspected the filter to this unit and found it coated with dirt/dust (see Picture 23). As with the AHU, the activation of the air conditioner can re-aerosolize dirt, dust and particulate, which can be irritating to certain individuals.

The building showed signs of insect infestation. A number of insect bodies were noted above lighting fixtures (see Picture 24). Insect parts can become dried out and aerosolized and may serve as a source of allergenic material for sensitive individuals. The most likely route for insect penetration into the building is through spaces around attic windows. BEHA staff noted a large number of dead insects on and around attic windows. Once inside the attic, insects attracted to light appear to have entered light fixtures through small openings in the fixtures where they became trapped. Under current Massachusetts law that will go into effect November 1, 2001, the principles of integrated pest management (IPM) must be used to remove pests in state buildings (Mass Act, 2000). Although the NAPD is not a state building, the principals of IPM are recommended as a safer alternative to the application of pesticides. A copy of the IPM guide is attached as Appendix A. Pesticide use indoors can introduce chemicals into the indoor environment that can be a source of eye, nose and throat irritation. The reduction/elimination of pathways of egress into the building should be the first step taken to eliminate this infestation.

A number of complaints of poor housekeeping and routine maintenance were expressed to BEHA staff. Carpets can act as reservoirs for tracked-in dust and dirt and can become re-aerosolized as a result of foot traffic. Accumulated dirt, dust and debris were noted on floors, carpeting and other flat surfaces throughout the building. Aerosolized dust and other particulates can be irritating to the eyes, nose and respiratory tract.

Conclusions/Recommendations

Occupant symptoms and complaints at the NAPD are consistent with what might be expected with conditions found in the building at the time of the assessment. These conditions present problems that will require a series of remedial steps. The lack of fresh air and exhaust ventilation results in air being re-circulated in the building. The AHU does not remove environmental pollutants from the building. This can result in a buildup of dust, dirt, and other pollutants in the indoor environment. For this reason a two- phase approach is recommended, consisting of **short-term** measures to improve air quality and **long-term** measures that will require planning and resources to adequately address the overall indoor air quality concerns within the building.

In view of the findings at the time of this visit, the following **short-term** recommendations are made:

1. A preventative maintenance program for all HVAC equipment should be developed and implemented, which should include changing filters for AHU equipment as per the manufacturer's instructions or more frequently if needed, as well as the examination of all HVAC equipment periodically for maintenance and function.
2. After replacing filters, reinstall filter access plate and operate the ventilation system during building occupancy.
3. Consider setting thermostat controls in the detective's unit to the "on" position to provide constant supply and exhaust ventilation during periods of occupancy.

4. Repair damaged flexible ductwork above ceiling tiles in the basement restroom. Operate the rest room exhaust vents to prevent odors entering occupied areas. Consider placing a timer to run the vent system during office hours.
5. Ensure basement return vents (e.g., secretary's office) are clear of obstructions to allow for proper airflow.
6. Consider having the ventilation system balanced by an HVAC engineer.
7. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations). Consider obtaining a vacuum cleaner equipped with a high efficiency particulate arrestance (HEPA) filter to trap respirable dusts. Wet wiping of flat, nonporous surfaces would also remove accumulated dust that can become aerosolized.
8. Remove/replace water damaged gypsum wallboard in secretary's storeroom. Once gypsum wallboard is removed area should be thoroughly inspected for water penetration through breaches in the building envelope. Disinfect areas of water leaks with an appropriate antimicrobial. Clean areas of antimicrobial application when dry.
9. Monitor basement storage area for leaks. Inspect cardboard boxes individually for water damage/mold growth, if moldy discard. If leakage reoccurs, store porous materials elsewhere.

10. Seal hole around electrical wires on exterior of building.

11. Seal cracks between the exterior wall/foundation of the building to prevent water penetration.

12. Repair any existing water leaks and replace any remaining water-stained ceiling tiles. Examine the areas above these tiles for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial as needed.

13. Replace water-damaged exterior door in the detectives unit.

14. Consider increasing the dust-spot efficiency of HVAC filters. Prior to any increase of filtration, each piece of air handling equipment should be evaluated by a ventilation engineer as to whether it can maintain function with more efficient filters.

15. Change filters in wall-mounted air conditioners as per the manufacturer's instructions to prevent the re-aerosolization of dirt, dust and particulate matter.

16. Use IPM to remove pests from the building. A copy of the IPM recommendations is included with this report as Appendix A (MDFA, 1996). Activities that can be used to eliminate pest infestation may include the following activities.

    i) Consult a licensed pesticide applicator on the most appropriate method to end infestation.

    ii) Reduction/elimination of pathways/food sources that are attracting pests.

    iii) Reduce harborages (plants/cardboard boxes) where pests may reside.

The following **long-term** measures should be considered.

1. Consider consulting a ventilation engineer concerning the introduction of fresh air. Have an HVAC engineer ascertain whether a fresh air intake and/or exhaust vent for the AHU can be installed.
2. Examine the feasibility of installing gutter/downspout system to the rear of the building.

References

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BOCA. 1993. The BOCA National Mechanical Code-1993. 8th ed. Building Officials & Code Administrators International, Inc., Country Club Hills, IL. M-308.1

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OSHA. 1997. Limits for Air Contaminants. Occupational Safety and Health Administration. Code of Federal Regulations. 29 C.F.R. 1910.1000 Table Z-1-A.

SBBRS. 1997. Mechanical Ventilation. State Board of Building Regulations and Standards. Code of Massachusetts Regulations. 780 CMR 1209.0

SBI. 2000. System Builders, Inc. HVAC Assessment for North Andover Police Department. North Andover, MA.

SMACNA. 1994. HVAC Systems Commissioning Manual. 1st ed. Sheet Metal and Air Conditioning Contractors' National Association, Inc., Chantilly,

Picture 1

North Andover Police Department, Portable Detective Unit in Foreground

Picture 2

NAPD HVAC System in Attic
Note no Provision for the Introduction of Fresh Air

Picture 3

Ceiling-Mounted Air Diffuser

Picture 4

Ceiling-Mounted Return Vent

Picture 5

Exhaust Ventilation System in Attic

Picture 6

Wall-Mounted Return Vent in Secretary's Office (Basement)

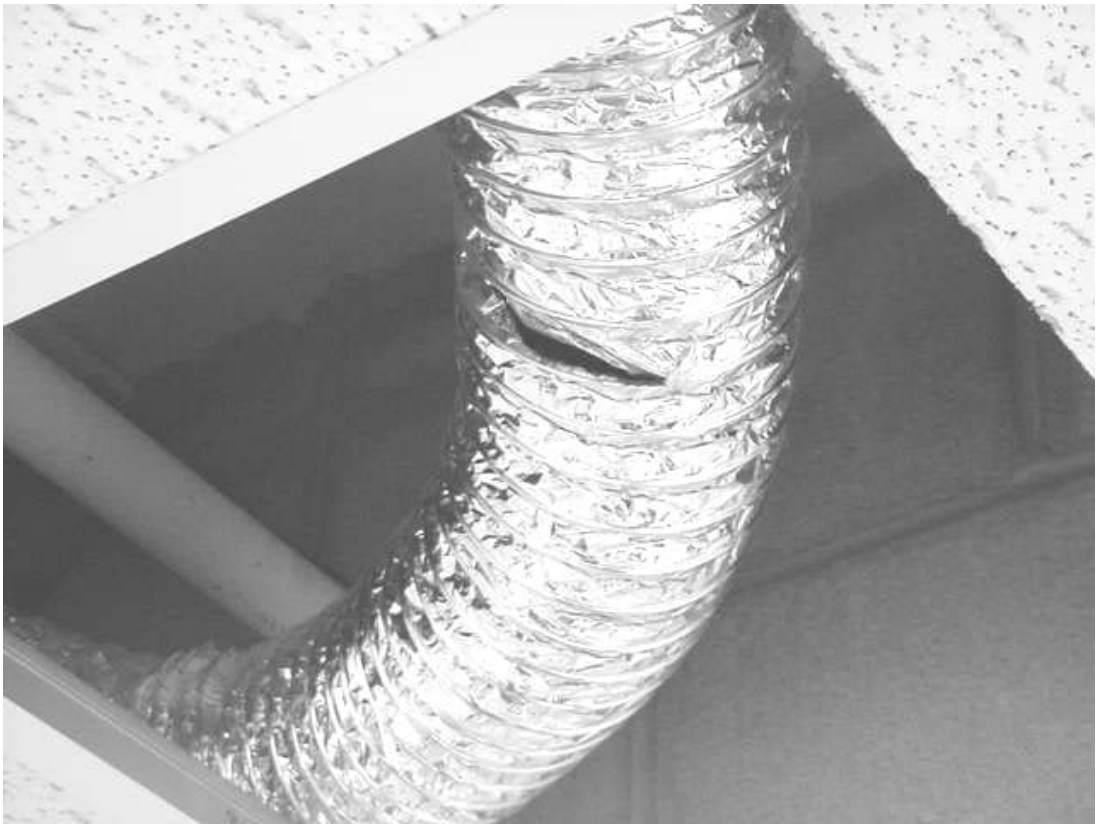
Picture 7

Passive Door Vent in Basement (Chief's Door)

Picture 8

Exhaust Vent Termini in Basement

Picture 9



Damaged Flexible Ductwork above Ceiling Tiles in Restroom

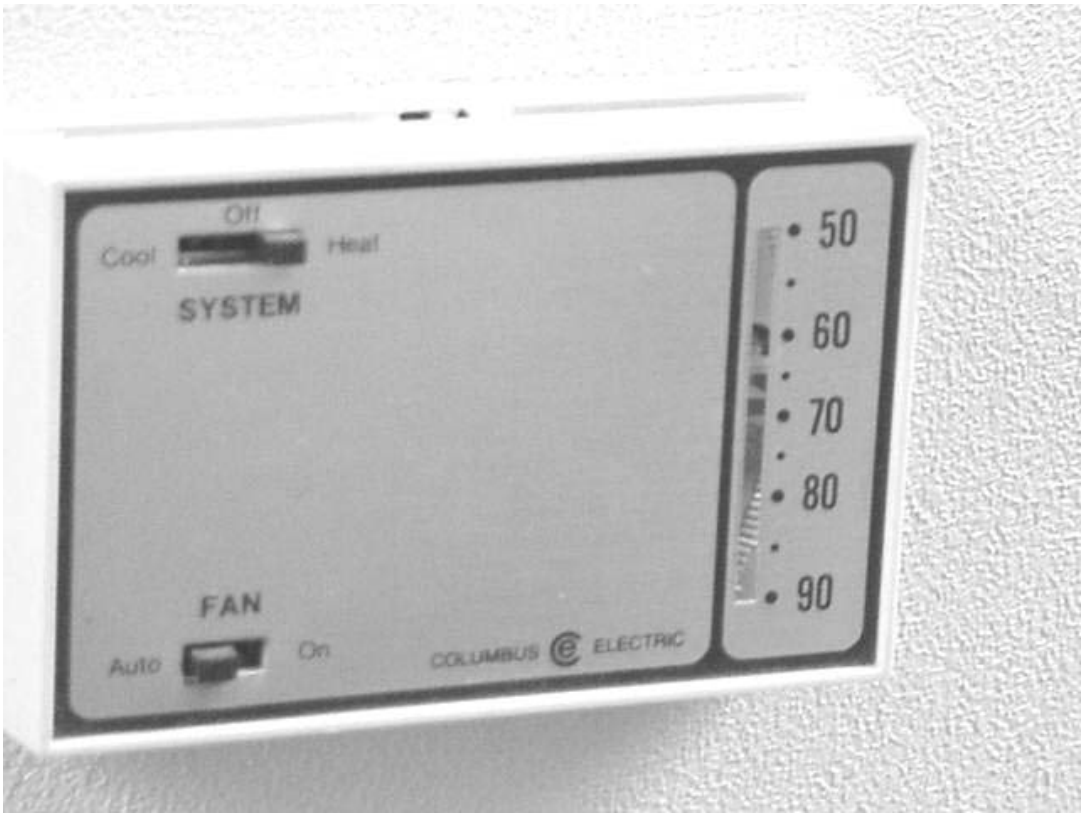
Picture 10

AHU for Detective Unit

Picture 11

Wall-Mounted return Vent in Detectives Unit

Picture 12



Thermostat Controlling AHU for Detectives Unit

Picture 13

Exterior Shot of Attic Exhaust Vent

Picture 14

Water Damaged Ceiling Tile with Possible Mold Growth in Basement Storeroom
Note Vertical Water Stain on Wall

Picture 15

Black Stains on Cement Floor underneath Boxes in Basement Storeroom

Picture 16

Black Substance Indicating Possible Mold Growth on Wallboard in Secretary's Storeroom

Picture 17

Seam between the Exterior Wall/Tarmac at the Rear of the Building (Outside of Secretary's Storeroom)

Picture 18

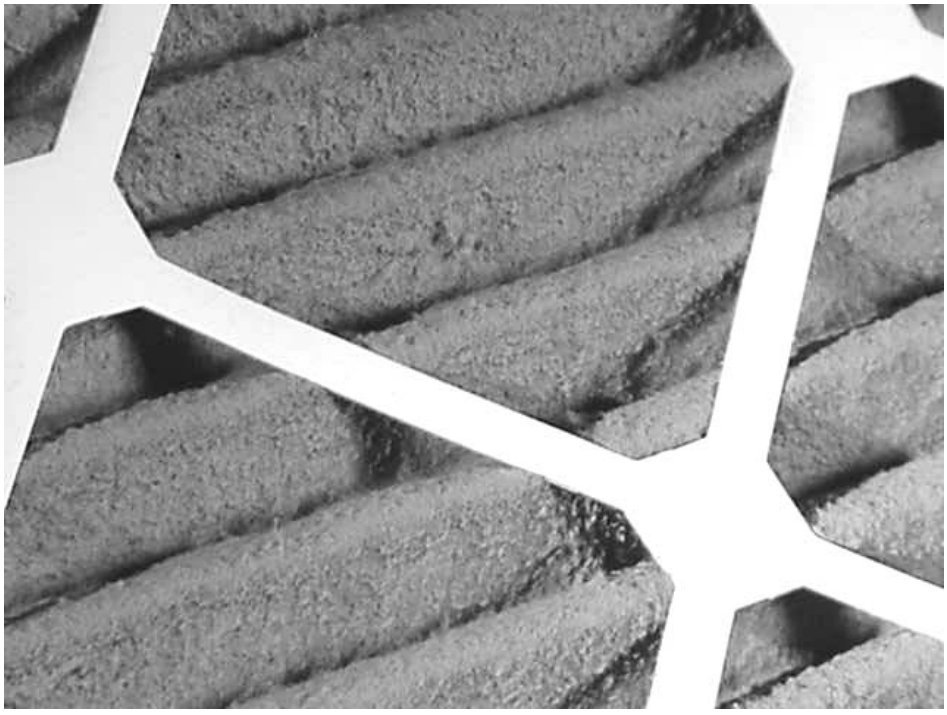
Picture 19

Corroded Exterior Door of Detectives Unit

Picture 20

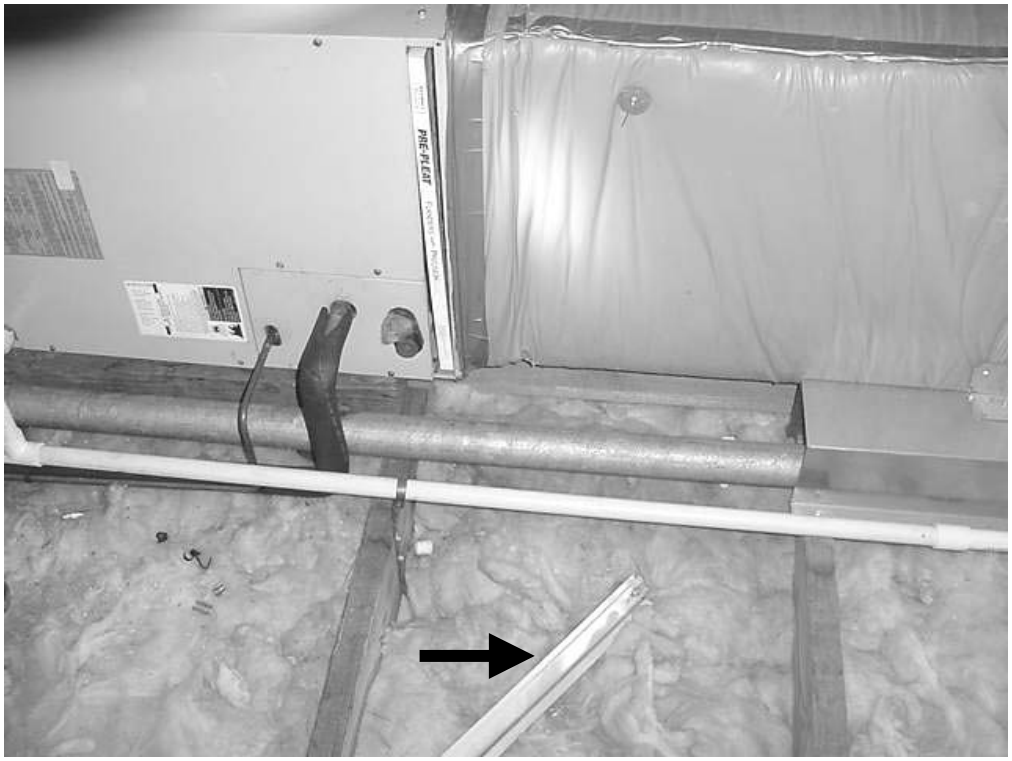
Fragments of Corroded Metal from Detectives Unit Door Note Carpeting in Hallway

Picture 21



Close-Up of AHU Filter Saturated with Dirt/Dust

Picture 22

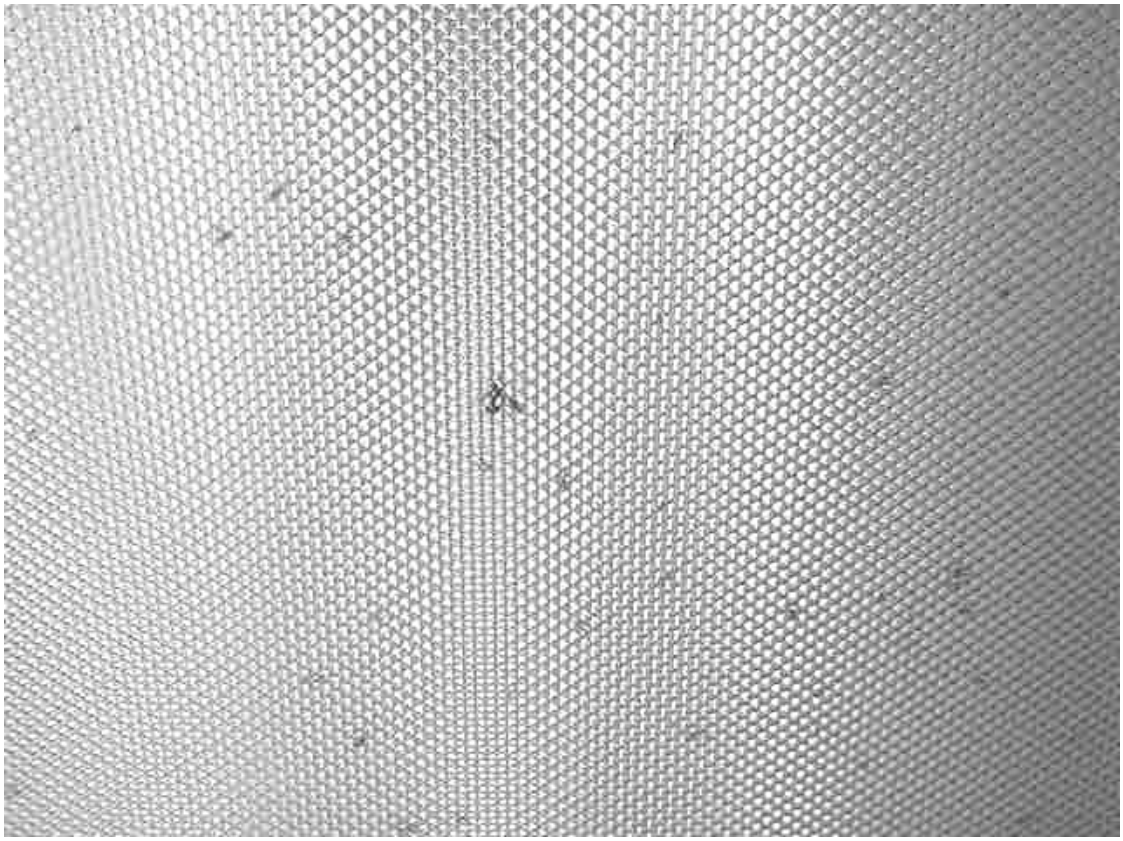


AHU in Attic Note Filter Access Cover Removed (Indicated by Arrow) and Exposed Fiberglass Insulation

Picture 23

Wall-Mounted Air Conditioner with Dirty Filter (Pulled Out) in Dispatch Area

Picture 24



Close-Up of Ceiling Mounted Light Fixture Dark Spots Indicate Insect Bodies

TABLE 1

Indoor Air Test Results – North Andover Police Station, North Andover, MA – March 21, 2001

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Outside (Background)	415	51	29					Weather conditions: overcast, breezy
Lt. Annson	1253	70	33	2	Yes	Yes	No	
Hallway							Yes	Thermostat on "Auto", exterior door weather strip damaged
Community Center	1400	73	28	2	No	Yes (3)	No	Wall mounted A/C-dirty filter, leaks around AC unit, dust complaints, 3 air intakes, missing CT-exposed wiring/fiberglass, dry erase board, carpet-dirty
Lt. Carney	1260	74	27	0	No	Yes	Yes	3 water damaged CT
O.I.C. Office	1487	72	28	2	No	Yes	No	Insect bodies above light, carpet-dirt/dust/debris
Safety and Training Office	1249	73	27	0	No	Yes	Yes	Missing CT – wires
Records	1370	73	27	2	Yes	Yes (2)	No	Photocopier
Support Services	1330	73	27	0	Yes	Yes	No	2 water damaged CT

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 2

Indoor Air Test Results – North Andover Police Station, North Andover, MA – March 21, 2001

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Booking	880	69	25	0	No	Yes	Yes (2)	Temperature complaints-cold
Female Cell	884	69	26	0	No	Yes	Yes	Exhaust off
Male Cells 1	873	67	26	0	No	Yes	No	
Male Cells 2	884	67	27	0	No	Yes	No	
Male Cells 3	916	69	27	0	No	Yes	No	
Copy Room	965	69	27	0	No	Yes	No	
Janitor's Closet							Yes	Exhaust off, flammables-paint thinner/mineral spirits (Xylene), bucket with wet mop & standing water
Garage/Storage Area	526	65	27	0	No	No	No	Flammables locker-nonflammables in locker (napkins/styrofoam cups), gas container-residual gas, water
Storage					No	No	No	stained CT, possible mold growth on floor

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

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	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 3

Indoor Air Test Results – North Andover Police Station, North Andover, MA – March 21, 2001

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Basement Restroom					No	No	Yes	Rip in flexible ductwork
Chief's Secretary's Office	805	67	30	1	No	Yes	Yes	
Chief's Secretary's Storage	810	69	29	0	No	Yes	No	Water damage at base of wall-possible mold growth-reportedly cleaned-reoccurring, carpet
Chief's Office		70	28	0	No	Yes		Passive vent
Chief's Restroom							Yes	Exhaust vent activated-no draw
Perimeter Notes								No gutters rear/north side of building, utility hole-cables
Roll Call	744	70	26	0	No	Yes	Yes	Carpet-accumulated dirt/dust, 7 water damaged CT-reportedly prone to plumbing leaks from restrooms/cell areas above
Locker Room	764	69	26	0	No	No	No	
Alarm/Telephone Room					No	No	No	Debris along wall/ceiling junction

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

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	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 4

Indoor Air Test Results – North Andover Police Station, North Andover, MA – March 21, 2001

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Armory	685	69	27	0	No	No	Yes	
Attic								No air intake on HVAC equipment, exhaust system deactivated-drafts
Detectives	1220	72	34	0	Yes	Yes	Yes	AHU on "Auto"
Dan's Office	1287	73	34	2	Yes	Yes	Yes	
Hefferann	1217	73	33	1	Yes	Yes	Yes	
Gallager	1290	75	31	1	Yes	Yes	Yes	
Exterior Door								Corroded/water damaged, carpet

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